METHODS AND SYSTEMS FOR OFF-LOADING A-INTERFACE SHORT MESSAGE SERVICE (SMS) MESSAGE TRAFFIC IN A WIRELESS COMMUNICATIONS NETWORK

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Description

METHODS AND SYSTEMS FOR OFF-LOADING A-INTERFACE SHORT MESSAGE SERVICE (SMS) MESSAGE TRAFFIC IN A WIRELESS COMMUNICATIONS NETWORK

Technical Field

The present invention relates to methods and systems for routing short message service messages in a wireless communications network. More particularly, the present invention relates to methods and systems for identifying and off-loading SMS message traffic from an A-interface in a wireless communications network.

Background Art

Short message service, which was first introduced by European wireless network operators in 1991, enables mobile subscribers to easily send and receive text messages via wireless handsets. As convergence of wireless communication networks and Internet data networks has increased, the sending and receiving of SMS messages via computer terminals has also become commonplace. Although specifications and industry standards related to SMS are constantly evolving and being modified, SMS messages have traditionally been used to convey readable text information, where the text can includes any combination of alphanumeric characters. After the initial

text messaging application, service providers began focusing on using SMS as a means for eliminating alphanumeric pagers by permitting two-way, general purpose messaging and notification services. One early example of SMS service was voice mail notification service. In voice mail notification service, users are sent text messages using short message service to notify the users of the presence of voice mail messages. As technology and networks continued to mature, a variety of services were introduced, including electronic mail (email) and fax integration, paging integration, interactive banking, and information services, such as stock quotes, news highlights, etc.

SMS delivery service provides a mechanism for transmitting "short" messages to and from SMS capable terminals (e.g., wireless handsets, personal digital assistants, personal computers, etc.) via the signaling component of the wireless communication network. With particular regard to the sending and receiving of SMS messages by a wireless handset, a wireless network provides the transport facilities necessary to communicate short messages between a short message service center (SMSC) and a wireless handset. An SMSC acts as a store and forward platform for short messages. In contrast to earlier text message transmission services, such as alphanumeric paging, SMS technology is designed to provide guaranteed delivery of an SMS message to a destination. That is, if a temporary network failure prohibits the immediate delivery of an SMS message, then the short message is stored in the network (i.e., stored at an SMSC) until the destination becomes available. Another of the key and distinguishing characteristics of SMS service with respect to previously available message communication services is that an active mobile handset is able to transmit or

receive a short message at any time, regardless of whether or not a voice or data call is in progress.

SMS can be characterized as an out-of-band packet delivery technique with low per-message bandwidth requirements. Hence, SMS services are appealing to network owners and operators.

Figure 1 is a network diagram illustrating an SMS implementation in a global system for mobile communication (GSM) wireless network. It will be appreciated that a functionally similar SMS architecture could also be employed in non-GSM wireless networks, such as American National Standards Institute 41 (ANSI-41) wireless networks. In any event, Figure 1 includes a wireless communication network, generally indicated by reference numeral **100**. Wireless network **100** is comprised of a number of components including a sending mobile terminal **110** that formulates and sends SMS message and a base transceiver station **112** / base station controller **113** pair that are collectively referred to as a base station system (BSS). A base station system manages the network-to-air interface and reliably transmits SMS messages into the core wireless network. In this particular example, the receiving end of the network includes a base station system **126** and a receiving mobile terminal **128**, both of which are functionally similar to the corresponding components on the sending side. Wireless network **100** also includes a pair of mobile switching centers (MSCs) **114** and **124**, a pair of signal transfer points (STPs) **116** and **122**, a short message service center **118** and a home location register (HLR) **120**.

As mentioned above, SMSC **118** is responsible for relaying, storing, and forwarding short messages between sending and receiving SMS

terminals. HLR **120** is a database platform used for permanent storage and management of mobile service subscriptions, mobile subscriber profiles, and mobile subscriber location information. HLR databases store information about subscribers that belong to the same network as the HLR. A database element known as a visitor location register (VLR) is used to temporarily store information about subscribers who are currently roaming in the area serviced by that VLR. The VLR may belong to the subscriber's home network or to a foreign network. Typically, VLR databases are integrated within MSC network elements, and, as such, a stand-alone VLR node is not shown in Figure 1. The HLR and VLR store information needed to correctly route voice calls or data communications to the mobile subscriber. This information may include an international mobile station identification (IMSI), a mobile identification number (MIN), a mobile directory number (MDN), and/or a mobile station ISDN number (MSISDN), as well as the IDs of the VLR and MSC with which the subscriber is currently associated.

With particular regard to short message service operations, HLR **120** provides SMSC **118** with network routing information for the receiving mobile subscriber or mobile terminal **128**. In certain cases, HLR **120** may also inform SMSC **118** that a mobile station is now recognized by the mobile network to be accessible after unsuccessful short message delivery attempts to the mobile station.

MSC **114** is sometimes referred to as an SMS inter-working MSC (SMS-IWMSC) because it is capable of receiving a short message from a wireless network and transmitting the short message to the appropriate SMSC. In practice, SMS-IWMSC nodes are typically integrated with the

SMSCs. In a similar manner, MSC **124** is sometimes referred to as an SMS gateway MSC (SMS-GMSC) because it is capable of receiving a short message from an SMSC, interrogating a home location register for routing information, and delivering the short message to the visited MSC of the recipient mobile station.

Within the Internet domain, email servers may communicate email-originated SMS messages to an SMSC serving subscribers in a wireless communication network. As such, an SMS message may be generated by a wireline computer terminal residing within a data network (e.g., the Internet) and sent to a mobile terminal within a wireless network, and vice versa.

The core signaling infrastructure of wireless network **100** is based on signaling system no. 7 (SS7), a telecommunications industry standard signaling protocol. A detailed discussion of SS7 signaling message types and their associated functions can be found in *Signaling System #7* by Travis Russell, McGraw-Hill Publishing, 1998. Additionally, a detailed discussion of SS7-related signaling within a GSM network can be found in *The GSM System for Mobile Communications* by Michel Mouly and Marie-Bernadette Pautet, Cell & Sys, 1992.

SMS service makes use of the SS7 signaling connection control part (SCCP) and mobile application part (MAP) protocols. Depending upon the particular implementation, SMS service may also utilize the transaction capabilities application part (TCAP) component of the SS7 protocol. With regard to TCAP-based SMS service, both American and international standards bodies have defined a MAP layer using the services of the SS7 TCAP component. The American standard is published by

Telecommunication Industry Association and is referred to as ANSI-41, while the international standard is defined by the European Telecommunication Standards Institute and is referred to as GSM MAP.

Figure 2 is a message flow diagram associated with the sending of a short message (SM) by a mobile subscriber in a GSM wireless network. In step **1**, a short message, such as a text message, is originated by sending mobile station **110** and transmitted to base station controller **113**. The message used to communicate the short message from sending mobile station **110** to base station controller **113** is a short message relay protocol data (SM-RP-DATA) message contained within a short message control protocol data (SM-CP-DATA) message. In step **2**, BSC **113** delivers the CP-DATA message to MSC **114** over an interface referred to as the A-interface. In mobile communications networks, the A-interface is the interface between the BSC and the MSC. In response to receiving the CP-DATA message, MSC **114** formulates a ForwardMOShortMessage message and routes the message to the appropriate short message service center (SMSC) node **118**, as indicated in step **3**. Upon receiving the ForwardMOShortMessage message, SMSC **118** generates an SM-RP-ACK containing ForwardMOShortMessageResponse message which is routed back to originating MSC **114** (step **4**). In response to receiving the ForwardMOShortMessageResponse message, MSC **114** places the SM-RP-ACK component within an SM-CP-DATA message and transmits the message via the A-interface link to originating BSC **113** (step **5**). BSC **113** subsequently notifies the originating mobile subscriber that the SMS message was sent (step **6**).

As the popularity of SMS messaging increases among wireless (and Internet) subscribers, the amount of wireless signaling traffic that traverses the core mobile signaling network will also increase, given the fact that SMS information is currently communicated via the SS7 signaling component of the wireless network instead of the voice or bearer path. From a bandwidth or signaling resource perspective, SMS traffic competes with other mobile signaling traffic, such as call-setup or location management-related messaging. Such SMS-related increases in the volume of signaling traffic leads to signaling congestion at a variety of signaling points in the mobile signaling network, particularly at mobile switching center nodes.

Conventional solutions to dealing with increased SMS traffic are commonly referred to as SMS-offloading techniques because these techniques off-load SMS traffic from the core signaling network to a data network. However, these conventional solutions do not address increased SMS traffic at MSCs because these solutions only offload SMS traffic downstream from the MSCs. In light of all of the call setup, teardown, and other functions performed by MSCs, there exists a long-felt need for methods and systems for reducing SMS traffic at the MSCs.

Disclosure of the Invention

According to one aspect, the present invention includes a signaling message routing node that off-loads SMS messages received from the base station controller component of a base station system via the A-interface. The routing node includes a discrimination application for examining signaling messages received via the A-interface and determining whether a received

signaling message is a short message service message. In response to determining that a signaling message received from a BSC node via the A-interface is an SMS message, the message is off-loaded from the core mobile SS7 signaling network and routed towards the appropriate destination without involving the MSC node that serves the BSC. In one exemplary implementation, the SMS message may be encapsulated within an Internet protocol (IP)-based transport adapter layer interface (TALI) protocol packet and transmitted into an IP network.

An SMS off-loading routing node of the present invention may also perform the signaling operations necessary to establish, maintain, and release communication channel resources used in the transmission of an SMS message.

Accordingly, it is an object of the present invention to provide a system and method for routing a short message service message to a recipient without involving the mobile switching center serving the mobile subscriber who originated the SMS message.

It is another object of the present invention to reduce the amount of SMS traffic in the core signaling system 7 signaling network component of a mobile communications network by off-loading some or all SMS messages from the core SS7 network to an Internet protocol network.

It is another object of the present invention to reduce the amount of SMS traffic in the core signaling system 7 signaling network component of a mobile communications network by off-loading some or all SMS messages from the core SS7 network to a general packet radio service (GPRS) network.

It is another object of the present invention to provide a system and method for routing a short message service message to a recipient without involving the mobile switching center serving the recipient.

It is another object of the present invention to identify SMS messages on an A-interface link in a wireless communications network and off-load the SMS messages for routing and transmission via an Internet protocol network.

Some of the objects of the invention having been stated hereinabove, other objects will be evident as the description proceeds, when taken in connection with the accompanying drawings as best described hereinbelow.

Brief Description of the Drawings

A description of the present invention will now proceed with reference to the accompanying drawings of which:

Figure 1 is a network diagram illustrating network elements associated with SMS service;

Figure 2 is a message flow diagram associated with the sending of an SMS message;

Figure 3 is block diagram of a signaling gateway routing node suitable for use with embodiments of the present invention;

Figure 4 is a schematic diagram of an SMS off-load routing node including an SMS off-load module (SOM) according to an embodiment of the present invention;

Figure 5 is a message flow diagram illustrating exemplary SMS-related signaling message communications in an SMS transmission scenario according to an embodiment of the present invention;

Figure 6 is a message flow diagram illustrating exemplary SMS-related signaling message communications in another SMS transmission scenario according to an embodiment of the present invention;

Figure 7 is a schematic diagram of an SMS off-load routing node including an external short message off-load processing and billing platform according to an embodiment of the present invention; and

Figure 8 is a network diagram including a short message off-load routing node according to an embodiment of the present invention.

Detailed Description of the Invention

Disclosed herein are several embodiments of the present invention, some of which may include an underlying hardware platform similar to that of high performance signal transfer point and signaling gateway products are marketed by Tekelec of Calabasas, California as the Eagle® STP and IP⁷ ™ Secure Gateway. A block diagram that generally illustrates the base internal architecture of an IP⁷ ™ Secure Gateway product is shown in Figure 3. In Figure 3, gateway **250** includes the following subsystems: a maintenance and administration subsystem (MAS) **252**, a communication subsystem **254**, and an application subsystem **256**. MAS **252** provides maintenance communications, initial program load, peripheral services, alarm processing, and system disks. Communication subsystem **254** includes an interprocessor message transport (IMT) bus that is the main communication bus among all subsystems in **250**. This high-speed communications system includes two 125 Mbps counter-rotating serial rings.

Application subsystem **256** includes application cards capable of communicating with the other cards via the IMT bus. SG **250** may include numerous modules, such as: a link interface module (LIM) **258** that provides a signaling system 7 message transfer part (SS7/MTP) signaling interface, a data communication module (DCM) **260** that provides a transport adapter layer interface (TALI) over transmission control protocol/Internet protocol (TCP/IP) signaling interface, and an application service module (ASM) **262** that provides global title translation, gateway screening and other services. A translation service module (TSM) **264** may also be included to support triggered number portability service.

SMS Off-load Routing Node Architecture

Figure 4 illustrates an SMS off-load routing node according to an embodiment of the present invention. In Figure 4, short message service off-load routing node **300** includes an interprocessor message transport bus **304** that is the main communication bus among internal subsystems within the switch or routing node. A number of distributed processing modules or cards may be coupled to IMT bus **304.** In Figure 4, these modules include a pair of maintenance and administration subsystem processors **306**, an SS7-capable link Interface module **308**, an Internet protocol capable data communication module **330**, and an SMS off-load module **340**. These modules may be physically connected to IMT bus **304** such that SMS signaling and other type messages may be routed internally between active cards or modules. For simplicity of illustration, only single LIM, DCM, and SOM cards are included in Figure 4. However, SMO routing node **300** may include multiple LIM, DCM,

SOM and other cards, all of which may be simultaneously connected to and communicating via IMT bus **304**.

MASP pair **306** provide maintenance communications, initial program load, peripheral services, alarm processing and system disks. As the MASP pair are not particularly relevant to a discussion of SMS off-load application functionality, a detailed discussion of their design and operation is not provided herein.

Focusing now on LIM functionality, in the illustrated embodiment, LIM **308** includes of a number of sub-components, such as an SS7 message transfer part level 1 and 2 application **310**, an I/O buffer or queue **312**, a gateway screening (GWS) application **314**, an SS7 MTP level 3 discrimination application **316**, and a distribution application **318**. MTP level 1 and 2 application **310** sends and receives digital data over a particular medium and provides error detection, error correction, and sequenced delivery of SS7 message packets.

In the illustrated embodiment, MTP level 1 and 2 application **310** transmits and receives signaling messages via a wireless network A-interface link **302**. Such messages may include SCCP messages. I/O queue **312** temporarily buffers incoming and outgoing signaling message packets. GWS application **314** examines received messages and determines whether the messages are to be allowed into the switch for processing and/or routing. Discrimination application **316** performs a discrimination function, effectively determining whether an incoming SS7 message packet requires internal processing or is simply to be through switched, i.e., routed to another node. For example, discrimination application **316** may examine a service indicator

octet (SIO) value in a received message packet in order to determine whether the message is an SCCP message and consequently whether SCCP-type processing is required. Distribution application **318** distributes messages that require additional processing prior to final routing.

DCM **330**, shown in Figure 4, includes an SS7/IP converter **332** and an I/O queue **334**. SS7/IP converter **332** sends and receives SS7 messages via an IP signaling link **333**. I/O queue **334** stores message to be processed by higher and lower layers. Outgoing SS7 message packets routed through DCM **330** may be transmitted out of SMS off-load routing node **300** and into an Internet protocol network via IP signaling link **336**. Since the MTP protocol and the IP protocol are not inherently compatible, SS7 message packets that are to be transmitted via an IP network may be encapsulated within an IP routing envelope prior to transmission. In one embodiment, SS7/IP converter **332** performs this IP encapsulation. Exemplary messages that may be transmitted by DCM **330** include transport adapter layer interface protocol messages, session initiation protocol (SIP) messages, M2UA, M3UA, SUA, SCTP or other message types that may be transported via TCP/IP or other IP-based protocols. DCM **330** may also communicate signaling messages via a general packet radio services network. The general packet radio service protocol that may be implemented by DCM **330** may include the General Packet Radio Service described in Digital Cellular Telecommunications System (Phase 2+) (GSM); General Packet Radio Service (GPRS), Service description, Stage 1 TSI EN 301 113 V6.1.1 (1998-11), the disclosure of which is incorporated herein by reference in its entirety.

Preferred packet formats for encapsulating various types of SS7 messages in IP packets are described in IETF RFC 3094, April 2001, the disclosure of which is incorporated herein by reference in its entirety. The present invention is not limited to the above-referenced TALI signaling protocol. Other functionally similar signaling protocols may be employed within the scope of the present invention, including for example, the IETF SUA/M3UA/SCTP or ETSI GPRS protocols.

In general, an SMS SOM card includes applications and databases for performing A-interface SMS off-loading. In Figure 4, SOM **340** is coupled to and serviced by an external provisioning application platform (EPAP) subsystem **398** via an Ethernet connection. EPAP subsystem **398** is responsible for administration and maintenance of the SMS off-load routing data resident on SOM **340**.

<u>SMS Off-load Module Architecture</u>

In Figure 4, SOM **340** includes a signaling connection control part application **342**. SMS off-load module **340** also includes an SCCP manager or controller known as a signaling connection routing controller (SCRC) **344**. The primary function of SCRC **344** includes directing an incoming SCCP message to an SMS off-load application (SOA) **346**. SCCP message packets leaving SCRC **344** are received and further processed by a routing application **348**. Routing application **348** has access to routing tables and is responsible for the external routing of SS7 message packets that have been processed by SMS off-load application **346** that do not require additional processing by SMS off-load routing node **300**. That is, routing application **348** determines to

which LIM or DCM an SCCP message should be routed for subsequent outbound transmission from SMS off-load routing node **300** after SMS off-load processing.

As discussed above, SOM card **340** includes one or more data tables that contain information for implementing the SMS off-load functionality of the present invention. Table 1 shown below illustrates a simplified structure intended to illustrate exemplary information that may be used to perform SMS message off-loading according to an embodiment of the present invention.

Table 1: SMS Off-load Screening Data

KEY	DATA	
SMSC Entity Address	DPC	RI
9195555506	5-5-5	SSN
9195555507	7-5-6	GT
9195555508	5-5-7	SSN

The SMS off-load screening data shown in Table 1 may be accessible by SMS off-load application **346** for performing SMS off-load functions. In Table 1, each entry includes short message service center entity addresses targeted for off-loading and provides a mapping of SMSC entity addresses to valid network addresses or point codes. Each entry in Table 1 also includes a routing indicator. The destination point code to which each SMSC entity address is mapped may correspond to an SMSC in a core mobile SS7 network. In an alternate implementation, the SS7 point code associated with

each SMSC entity address may correspond to an intermediate network element, such as a routing node (e.g., signal transfer point, signaling gateway, IP router, etc.). Depending upon the particular architecture of the network in which SMS off-load routing node **300** is deployed, the network address information stored in Table 1 may correspond to an IP network address (e.g., IP address and port number, URL, or other IP-related address information).

As discussed above, each entry in the SMS off-load data structure illustrated in Table 1 includes an SS7 destination point code and associated routing indicator. The information stored in the DPC and RI fields is used during off-load routing operations to divert SMS messages from the core mobile SS7 signaling network. The routing indicator is used to indicate whether an off-loaded signaling message requires global title translation. In such an embodiment, the presence of a particular SMSC entity address in the data structure shown in Table 1 indicates that an SMS message destined for that SMSC entity is to be off-loaded from the core mobile SS7 signaling network. Additional checks may also be performed to ensure that a received SMS message destined for a provisioned SMSC entity address was originated by an authorized mobile subscriber. For instance, a mobile subscriber that has been ported out of a particular operator's network may retain the ability to originate an SMS message addressed to one of the operator's SMSC. An additional check of the originating mobile subscriber's mobile identifier (e.g., IMSI, TMSI, MSISDN, etc.) may be used for unauthorized access screening.

A short message generated in a non-SS7 signaling protocol, such as the session initiation protocol, may utilize SMSC entity and mobile subscriber identifiers that differ from those illustrated in Table 1. For example, an SMSC

entity address specified in a SIP/SDP SMS message may include an Internet protocol address (e.g., 101.10.12.32), a uniform resource locator (e.g., www.tekelec-SMSC.com), or an electronic mail address (e.g., smsc@mail.tekelec.com). Similarly, a mobile subscriber identifier specified in a SIP/SDP SMS message may include an IP address, uniform resource locator, or electronic mail address for the mobile subscriber. Furthermore, in an embodiment of the invention capable of screening SIP/SDP messages, the destination address information associated with each SMSC entity address and mobile subscriber in the SMS off-load data structure may be an IP network address, uniform resource locator, or electronic mail address that identifies the destination. Any address that can be used to identify a message as an SMS message destined for a core mobile network element, such as an MSC is intended to be within the scope of the invention.

The SMS off-load data structure shown in Table 1 is presented primarily for the purposes of illustration. Practical implementations of an SMS off-load application of the present invention may include more complex or different internal data structures. For example, the SMS off-load data may be stored in a tree or trie data structure to improve lookup efficiency.

SMS off-load module **340** may also include a table or data structure for mapping IMSIs and TMSIs to MSISDN numbers. Table 2 illustrates exemplary IMSI/TMSI to MSISDN mappings that may be stored by SOM **340**. The IMSI to MSISDN mapping data shown in Table 2 may be provisioned by a network operator or obtained from other databases residing in the network (e.g., from a home location register, from a visitor location register, etc.) The TMSI mapping information may be dynamically maintained through an

external provisioning system or by the SMO routing node itself. In the case where SMS off-load routing node **300** obtains mapping information dynamically, non-SMS related signaling messages, such as Location_Updating_Accept or a TMSI_Reallocation_Command messages, may be intercepted by SMS off-load application **346**. SMS off-load application **346** may then extract information for mapping a TMSI to an MSISDN number.

Table 2: IMSI / TMSI Mapping Data

IMSI	TMSI	MSISDN
9193620000	-	9193457012
9193620001	-	9192600323
9193620003	2348881010	9192600032

The mappings stored in Table 2 may be used to prevent unauthorized access to an SMSC when a subscriber has been ported from a network having a particular SMSC. For example, a ported subscriber may attempt to send a message using his or her former SMSC. Messages from the subscriber may be identified by MSISDN, TMSI, or IMSI. SMS off-load application **346** may intercept these messages using the data stored in Table 2, and off-load such messages to a data network. The messages may be routed back to their original destinations.

Table 3 shown below illustrates exemplary SMS off-load routing data that may be used by routing application **348** on SMS off-load module **340**. In Table 3, each entry includes one or more keys or fields that may be used to index into the routing data. In the illustrated example, the keys include an International Telecommunications Union - international (ITU-I) network point code field, an International Telecommunications Union - national (ITU-N)

network point code field, and an American National Standards Institute (ANSI) network point code field. Only one of the provisioned network address fields is accessed during a typical lookup operation. The particular address field selected is determined by the format of the base SS7 protocol employed on the A-interface link being monitored by the SMO routing node.

In Table 3, each entry includes a plurality of routing-related data fields, such as a route cost field, a linkset status field, an adjacent node status field, an overall status field, and a linkset name or identifier. The primary function of the routing data shown in Table 3 is to define one or more signaling routes for a point code and to associate an internal linkset identifier with each defined route.

Table 3: SMS Off-load Routing Data

Keys			Route Cost	LinkSet Status	Adjacent Status	Overall Status	Name
ITU-I	ITU-N	ANSI					LS1
5-5-5	2-4-7	-	10	A	A	A	LS2
5-5-5	2-4-7	-	20	P	A	P	LS3
5-5-5	2-4-7	-	30	A	A	A	LS4
5-5-6	2-4-1	-	20	A	P	P	LS5
5-5-6	2-4-1	-	30	A	A	A	LS6
-	-	5-5-8	20	A	A	A	LS7
-	-	7-1-1	10	A	A	A	LS8

Table 4 shown below illustrates exemplary linkset data used by routing application **348** of SOM module **340**. In Table 4, each entry includes a compound key or index that includes a linkset identifier and a signaling link field. Each entry also includes IMT address and communication port fields, which contain IMT bus address and communication port information associated with communication modules that are connected to IMT bus **312**. More particularly, each entry in the linkset table includes an IMT address and

communication port value associated with a communication module that supports the specific link identified by the key associated with the entry. For example, as shown in Table 4, link 0 of linkset 1 resides on a communication module that has an IMT bus address of 1305 and a communication port address of "A." Furthermore a link status field indicates that link 0 of linkset 1 is available for service. Also included in the linkset table is an adjacent point code (APC) field which contains information that identifies a signaling node adjacent to SMS off-load routing node **300**, i.e., connected directly to the distant end of a signaling link that is also connected to SMS off-load routing node **300**.

Table 4: SMS Off-load Linkset Data

Linkset Name	Link	IMT / Card Address	Port	Link Status	Socket	Adjacent Point
LS1	0	1305	A	A	Sock1	5-4-7
LS1	1	1307	B	U	Sock2	5-4-7
LS2	1	1505	B	A	Sock3	5-4-7
LS2	2	2301	A	A	Sock4	5-4-7
LS5	0	3301	A	A	Sock5	--
LS5	1	3312	B	A	Sock6	--
LS8	1	1105	A	A	Sock7	9-0-1

In one embodiment, SMS off-load module **340** performs a first database lookup in the SMS off-load routing table (Table 3). This lookup returns an index value or pointer that may be used in a second lookup in the linkset table (Table 4). The ultimate result of this two-stage lookup procedure is an IMT bus address, communication port, and TCP/IP socket identifier associated with a signaling link on a communication module. The TCP/IP socket identifier is subsequently used to obtain IP address information from Table 5 (shown below) prior to off-loading SMS messages from an A-interface to an IP network.

Table 5 shown below includes exemplary socket data for off-loading SMS messages to an IP network according to an embodiment of the present invention. In Table 5, each entry includes a socket identifier, local address and TCP port information, remote IP address and TCP port information, and socket status information. The socket identifier is used as a key to each entry. The IP address and port information may be used to build TCP and IP headers in packets used to off-load SMS messages. The socket status field indicates whether a socket is available or unavailable.

Table 5: Socket Data

Socket	Local IP Address	Local TCP Port	Remote IP Address	Remote TCP Port	Socket Status
Sock1	10.01.01.10	13	10.20.01.01	34	A
Sock2	10.01.01.10	14	10.20.01.02	43	A
Sock3	10.01.01.10	15	10.20.01.03	76	U
Sock4	10.01.01.10	16	10.40.01.01	56	A
Sock5	10.01.01.10	17	10.40.01.02	55	A
Sock6	10.01.01.10	18	10.50.01.01	83	A

The data structures shown in Tables 1-5 are merely illustrative data used to identify and off-load SMS messages from an A-interface to a data network. Alternate data and/or data structures may be used without departing from the scope of the invention.

A short message service off-load routing node of the present invention may receive messages and respond (on behalf of an MSC node) to certain types of signaling messages that are normally communicated between a BSC node and an MSC node via an A-interface link. In one embodiment, an SMO routing node may intercept signaling message packets that contain specific types of short message relay protocol (SM-RP) messages. For example, an SMO routing node may process received short message control protocol (SM-

CP) signaling messages (e.g., CP-DATA messages) that include RP message components associated with mobile subscriber-to-MSC SMS communications. Table 6 shown below includes a listing of exemplary mobile originated RP messages and their associated RP message types.

Table 6: SM-RP Message Types

RP MTI Bit Sequence	RP Message
000	RP-Data
010	RP-Ack
100	RP-Error
110	RP-SMMA

In Table 6, the column labeled “RP MTI Bit Sequence” contains message type identifiers that SMS routing node **300** may use to identify SMS-RP data messages. The second column in Table 6 illustrates the corresponding message types. In the event that an SM-CP message is received from a BSC node and that message is targeted for off-loading from the core mobile SS7 signaling network, an SMO routing node of the present invention may terminate the CP message and generate one or more appropriate response messages.

Referring again to Figure 4, in one embodiment, SMS off-load application **346** may include an SM-CP manager **350**, a short message RP-to-MAP protocol translator **352**, and a connection manager **354**. SM-CP manager **350** administers or manages SM-CP related communication tasks, such as the SM-CP message termination and generation functionality mentioned above. RP-to-MAP protocol translator **352** may generate specific

SMS-related MAP signaling messages in response to the receipt of predetermined SM-CP-encapsulated RP messages. For example, if a CP-DATA message including a mobile-originated RP-DATA component is received, RP-to-MAP translator **352** may generate an associated MAP ForwardMOShortMessage message. The ForwardMOShortMessage message may be routed to a destination SMSC via an off-load network. Similarly, a MAP ReadyForShortMessage signaling message may be generated in response to receiving a CP-DATA signaling packet containing a mobile-originated RP-SMMA message. SM-CP manager **350** may generate a CP-ACK message in response to a received CP-DATA message and route the CP-ACK message back to the originating BSC node. SM-CP manager **350** thus maintains state information associated with a particular SM-CP connection or transaction, and manages the connection accordingly. SM-CP manager **350** may also generate CP-Error messages. Thus, SM-CP manager **350** facilitates and administers SM-CP-protocol-based communications with a peer network element (e.g., a BSC node) on behalf of the SMO routing node.

SMS off-load application **346**, SM-CP manager **350**, short message RP-to-MAP protocol translator **352** and connection manager **354** cooperate to receive and respond to incoming SMS-related MAP messages originated by an SMSC, as described above. For example, RP-to-MAP protocol translator **352** and SM-CP manager **350** may generate a CP-DATA message containing an RP-ACK component in response to the receipt of a MAP ForwardMOShortMessage_Response message from an SMSC. With particular regard to an RP-Error message and the associated MAP ForwardShortMessageError message, short message RP-to-MAP protocol

translator **352** may also translate RP error codes or cause values to the equivalent MAP error codes. For example, an RP-Error cause value of "22" may be translated to a MAP ForwardShortMessageError "MemoryCapacityExceeded" error code.

The SM-CP and SM-RP protocols, are described in detail in *European Telecommunications Standards Institute (ETSI) TS 100 942 v7.0.0 (1999-08) Digital cellular telecommunications system (Phase 2+); Point-to-Point (PP) Short Message Service (SMS) support on mobile radio interface (GSM 04.11 version 7.0.0 Release 1998)*, the disclosure of which is incorporated herein by reference in its entirety. Exemplary SMS-related MAP messages are described in detail in *ETSI TS 100 974 v7.6.0 (2000-09) Digital cellular telecommunications system (Phase 2+); Mobile Application Part (MAP) specification (3GPP TS 09.02 version 7.6.0 Release 1998)*, the disclosure of which is incorporated herein by reference in its entirety.

Figure 5 is an inter-node messaging diagram illustrating the sequenced flow of signaling messages associated with the sending of a mobile originated short message by a mobile subscriber in a network environment where authentication and encryption services are used during SMS communications. Figure 5 includes a base transceiver station (BTS) node **112**, a BSC node **113**, an SMO routing node **300**, an MSC node **114**, and an SMSC node **118**.

In Figure 5, a number of non-SMS-specific signaling messages are required during the course of a typical mobile-originated short message communication. Lines 1-5, 8, 9, 12, 13, 15, and 24-27 in Figure 5 illustrate exemplary DTAP messages that may be exchanged between BSC **113** and MSC **114** that are unrelated to SMS service. Since these messages are not

processed by SMS routing node **300**, these messages will not be described in detail herein. Similarly, lines 6, 7, 10, 11, 14, 23, and 28 are SCCP messages that are through switched by SMS routing node **300**. Accordingly, a detailed description of these messages will likewise not be presented herein.

In line 16 of the message flow diagram illustrated in Figure 5, SMO routing node **300** receives a CP-data message including an RP-data component on an A-interface from BSC **113** and terminates the CP-Data message. This message would normally be sent from BSC **113** to MSC **114** to trigger the originating of a MAP ForwardMOShortMessage (RP-data) message. However, according to the present embodiment, in line 17 of the message flow diagram, SMO routing node **300** generates its own MAP ForwardMOShortMessage (RP-data) and forwards the message to SMSC **118**. The message may be sent over an SS7 network, an IP network, or any other type of packet-based network capable of carrying MAP messages. In line 18 of the message flow diagram, SMO routing node **300** acknowledges the CP-data message generated by BSC **113** in line 16 of the message flow diagram. Such acknowledgement is normally performed by the MSC. In line 19 of the message flow diagram, SMO routing node **300** receives a MAP ForwardMOShortMessage acknowledgement message from SMSC **118**. In line 20 of the message flow diagram SMO routing node **300** sends a CP-data acknowledgement message including an RP-data acknowledgement component to BSC **113**. In line 21 of the message flow diagram, BSC **113** sends a CP-acknowledgement message to SMO routing node **300**. In line 22 of the message flow diagram, SMO routing node **300** sends an SCCP DT1 message including a BSSAP clear request component to free resources on

MSC **114**. Thus, as illustrated in Figure 5, SMO routing node **300** intercepts short message service messages destined for an MSC and formulates response messages that would normally be generated by the MSC. Accordingly, the processing load on the MSC is reduced.

Figure 6 is a message flow diagram illustrating messages associated with the origination of a short message service message where SMO routing node establishes an SCCP connection on behalf of an MSC. In Figure 6, lines 1-5 illustrate DTAP messages exchanged between BTS **112** and BSC **113** in order to establish a communication channel on the BSC for delivering an SMS message. These messages are not important in explaining the invention and hence will not be described in detail herein.

In line 6 of the message flow diagram, BSC **113** sends an SCCP connection request message to MSC **114**. However, rather than forwarding the SCCP connection request message to MSC **114**, SMO routing node **300** intercepts the SCCP connection request message and forwards an SCCP connection confirm message to BSC **113**. The SCCP connection confirm message confirms the availability of resources at an MSC to send an SMS message. However, because SMO routing node **300** intercepts SMS messages on the A interface that are destined for MSC **114**, SMO routing node **300** can confirm the availability of resources for sending the message. In steps 9-14, SMO routing node **300** performs the CP-data and MAP functions described above with respect to Figure 5 to deliver an SMS message to SMSC **118** without involving MSC **114**. In line 15 of the message flow diagram, SMO routing node **300** sends an SCCP release message to BSC **113** to release resources associated with the SMS message. In lines 16-

19 of the message flow diagram, BSC **113** and BTS **112** exchange DTAP messages for releasing the channel associated with the SMS message. Finally, in line 20, BSC **113** sends an SCCP release complete message to SMO routing node **300**. Thus, Figure 6 illustrates that SMO routing node **300** can reserve channel resources and subsequently deliver an SMS message on behalf of an MSC.

SMS off-loading application **346** illustrated in Figure 4 resides within a signal transfer point or signaling gateway type routing node. In an alternate embodiment of the invention, SMS off-loading application **346** may reside on an external workstation, indirectly coupled to IMT bus **304** of the routing node. Such an embodiment is illustrated in Figure 7, which includes an SMS off-load-enabled signaling message router that is generally indicated by reference numeral **400**.

The internal communications and control architecture of routing node **400** is similar to that described above for node **300**, and as such will not be discussed in detail again. However, in the embodiment presented in Figure 7, SMS off-load routing node **400** includes an external SMS off-load processing (ESP) platform **500** that receives SMS messages from the core routing node communications sub-system via an Ethernet (or functionally similar) connection. As such, SMS off-loading application **346** described above is resident on the ESP platform **500**, including applications **350**, **352**, and **354** (not shown). In this case, SMS off-loading application **346** is coupled to SMS off-loading module **340** via an Ethernet controller (EC) **502** located on SOM **340** and another EC **504** located on ESP platform **500**. The communication of information via an Ethernet connection is well known to those skilled in the art,

and consequently a detailed discussion of Ethernet controllers **502** and **504** is not presented herein. Ethernet controllers **502** and **504** communicate SMS messages received at SOM **340** to the ESP platform **500**, and vice versa.

In the embodiment shown in Figure 7, ESP platform **500** also includes databases and applications for performing usage measurements and billing functions related to the off-loading of SMS messages. An example of such usage measurements and billing information that may be collected by ESP platform **500** is shown in Table 7.

Table 7: SMS Off-load Usage Measurements and Billing Data

Date	Time	SMSC Entity	MS ID	DPC
12/01/2000	13:01:24	9195555506	9194671100	5-5-5
12/01/2000	13:01:26	9195555506	9194621450	5-5-5
12/01/2000	13:01:34	9195555507	9194671230	5-5-6

The sample usage measurements and billing data structure presented in Table 7 includes date and time stamp fields, an SMS message receiving SMSC entity identifier field, an SMS message sending mobile subscriber identifier field (e.g., originating mobile subscriber MSISDN, IMSI, electronic mail address, etc.), and an SMS message destination point code address field. In one embodiment of the present invention, such information may be maintained for SMS messages that are off-loaded from the core mobile SS7 switching network by the SMS off-load routing node. This information may subsequently be used for network management and/or billing purposes. The UMB data structure shown in Table 7 is merely illustrative of the types of information that may be tracked by a usage measurements and billing

application that operates in conjunction with an SMS off-load application of the present invention. Other data structures or message peg counting techniques may be used without departing from the scope of the invention.

SMS Off-load Operation

Figure 8 is a network diagram including an SMO routing node according to an embodiment of the present invention. In Figure 8, a wireless communication network **600** includes a short-message-originating mobile subscriber **110**, a base station transceiver system **112**, a base station controller **113**, a short message off-load routing node **300**, a serving mobile switching center/visitor location register node **114**, a short message service center node **118**, a mobile core signaling system 7 signaling network **602**, and an Internet protocol based off-load network **604**. The message flow diagram presented in Figure 6 can be used in conjunction with Figures 4 and 8 to generally illustrate the steps associated with SMS off-load processing of an SMS message according to one embodiment of the present invention. For purposes of illustration, only those signaling messages directly associated with communications between SMO routing node **300**, BSC node **113**, and the SMSC node **118** are described in the following example.

When a mobile subscriber **110** attempts to send a short message, BSC node **113** sends an SCCP Connection Request message to MSC node **114** via an A-interface signaling link. The SCCP ConnectionRequest message is received via link interface module **308** and is subsequently screened by LIM discrimination application **316**. If discrimination application **316** determines that the received message does not require SMS off-load processing, the

message may be routed from SMO node **300** via a communication module, such as a LIM without further SMS off-load processing. Upon determining that the received message is an SCCP message (e.g., service indicator value = 3) as is the case in this example, discrimination application **316** passes the message to distribution application **318** where the message is internally routed via IMT bus **304** to the short message off-load processing module **340**. SCRC **344** examines the contents of the received SCCP signaling packet and determines to which of the applications associated with SOA **346** the packet should be forwarded. SCRC **344** may examine a variety of parameters in order to make such a determination. For instance, in one embodiment, SCRC **344** may examine a CdPA SSN field in a received message. A CdPA SSN binary value of "11111110" indicates that the SCCP message contains BSSAP type information, and a discriminator parameter contained in a BSSAP header may subsequently be examined to determine the type of message/data components contained therein. For example, a BSSAP discrimination parameter binary value of "01" is typically used to indicate the presence of a DTAP information component, and SMS information is generally transported within DTAP type BSSAP messages.

Returning to the present example, the received message may include information (e.g., CM_seq parameter = SMS), which indicates that the message is related to SMS connection/communication channel resource management. The message is thus passed to connection manager **354** for processing. Connection manager **354** processes the ConnectionRequest message and, in response, generates an SCCP ConnectionConfirm message addressed to the originating BSC node **113**. This new ConnectionConfirm

message is routed via routing **348** to an appropriate A-interface LIM module for transmission to BSC node **113**. As such, the SCCP ConnectionRequest message is effectively intercepted and terminated by the SMO node **300** prior to receipt of the message by MSC node **114**.

After receiving the ConnectionConfirm message, BSC node **113** sends an SMS CP-DATA message to MSC node **114**. Again, prior to receipt of the CP-DATA message by MSC node **114**, the message is intercepted by SMO routing node **300**. The CP-DATA message is received by LIM **308** and directed to SOM **340** for short message off-load processing. In this case, the CP-DATA message is determined to contain a short message relay protocol "data" (RP-DATA) component and as such, the message is passed to the short message control protocol manager (SM) **350** for processing.

After successfully verifying the CP-DATA message, SM **350** generates a CP-ACK response message which is routed by routing application **348** to an appropriate A-interface LIM module for transmission to BSC node **113**. The CP-DATA message is then passed to the short message relay protocol-to-mobile application part translator **352**. Translator **352** examines the RP-DATA component of the CP-DATA message and generates an appropriate MAP message. More particularly, an RP message type indicator (RP-MTI) parameter contained in the SM-RP layer of the signaling message is examined to determine the type of RP message contained therein. For example, an RP-MTI binary value of "000" is used to indicate an RP-Data message that was originated by a mobile subscriber, whereas an RP-MTI value of "001" indicates an RP-Data message that is destined to a mobile subscriber. Table 6 presented above includes a listing of possible RP-MTI

values and their associated mobile originated RP message types that may be used by translator **352** in identifying and translating RP messages.

In this example, the MAP message generated by translator **352** is a ForwardMOShortMessage message. Unlike the previously generated signaling messages, which were routed via the A-interface back to BSC node **113**, the new MAP message is routed via routing application **348** to an appropriate IP network interface module **330** for transmission to or towards SMSC node **118** via the IP off-load network **604**. In one embodiment, communication DCM **330** may encapsulate signaling messages to be off-loaded in an transport adapter layer interface packet which is subsequently transmitted into an off-load network via a TCP/IP socket connection. As discussed above, the present invention is not limited to using the TALI protocol to off-load SMS messages. Any protocol for transmitting SMS messages over a packet-based network may be used.

With particular regard to RMT processing, an SMSC entity address contained within the received SCCP CP-DATA message may be used in conjunction with the SMS off-load screening data presented above in Table 1 to determine the intermediate or final destination address of the MAP message being off-loaded. Once the destination address is determined, route and linkset data tables (Tables 3 and 4) are may be used to select a specific signaling route and linkset. Translator **352** may extract an IMSI, TMSI, or functionally equivalent mobile subscriber identifier from the received SCCP CP-DATA packet and determine the associated MSISDN identifier using data contained in IMSI /TMSI mapping table (Table 2) described above. The appropriate MSISDN identifier is included in the MAP message that is off-

loaded to SMSC node **118**. Again, it should be noted that MSC node **114** is not involved in the generation and subsequent routing of either the CP-ACK or MAP ForwardMOShortMessage signaling messages. As a result, the processing load on the MSC is decreased.

Turning briefly to the SMO routing node embodiment illustrated in Figure 7, external SMS off-loading platform **500** in combination with the internal SMS off-load module **340** provides essentially the same short message off-loading functionality as described in the previous embodiment. However, ESP **500** is further to generate and maintain usage measurements and billing information related to the off-loading of SMS messages from the core mobile SS7 signaling network **602**. As such, within SMO routing node **400**, a received SMS signaling message packet is processed by LIM **308** in the manner described above. Once the received signaling message packet is identified as potentially requiring SMS off-load processing by LIM **308**, the message is internally routed via IMT bus **304** to SOM **340** for further examination. SCCP and SCRC processes **342** and **344**, perform the SCCP functions described above. In the event that processing by the short message off-load application **346** is indicated, SCRC process **344** directs the message to Ethernet controller **502**, which transmits the message to EC **504** residing on ESP **500**. Once EC **504** receives the message, EC **504** directs the message to SOA **346** where short message off-load processing is performed. In Figure 6, SOA **346** may communicate information extracted from the SMS message to the usage measurements and billing applications **506** and **508**, respectively. As such, usage measurements application **506** and billing application **508** may generate and maintain statistics and billing information

(e.g., the information shown in Table 7). Once again, with respect to RP-to-MAP message translation/generation, SOA **346** generates a MAP-based SMS response message, as described above. The resulting MAP message generated by SOA **346** is subsequently communicated Ethernet controllers **504** and **502** back to SOM **340** and ultimately via IMT bus **304** to DCM **330** for transmission into off-load network **604**.

Returning to the sample message sequence diagram shown in Figure 6, it will be appreciated that a MAP ForwardMOShortMessage_Ack or response message is sent by SMSC node **118** in response to the receipt of the associated MAP ForwardMOShortMessage. SMO routing node **300** receives the MAP ForwardMOShortMessage_Ack message and internally routes the message to SOM **340** for processing. In response to the receipt of such a MAP ForwardMOShortMessage_Ack message, SOA **346** generates a CP-DATA message, which is internally routed via routing **348** to an appropriate A-interface LIM module for transmission to BSC node **113**. BSC node **113** receives the CP-DATA message and, in response, generates an associated CP-ACK message that is transmitted back to SMO routing node **300**. As described above, this CP-ACK message is received by SMO node **300** and internally routed to SOA **346**. In this case, short message control protocol manager **350** notifies the connection manager (CM) **354** that the SMS communication session is complete. In response, CM **354** generates an SCCP CONNECTION_RELEASE message that is intended to inform BSC node **113** that the connection/communication channel resources associated with this SMS transaction are no longer required and consequently may be released. Upon receipt of the SCCP CONNECTION_RELEASE message,

BSC node begins the process of releasing the associated connection/communication channel resources and subsequently sends an SCCP CONNECTION_RELEASE_COMPLETE message which is received and processed by SMO routing node **300**.

A number of protocols may be used to transport an off-loaded signaling message through an off-load network, including SCCP user adaptation (SUA) over stream control transmission protocol (e.g., as described in IETF RFC 2960, the disclosure of which is incorporated herein by reference in its entirety) M2UA/SCTP, M3UA/SCTP, GPRS, etc. Regardless of the encapsulating protocol employed, an SMO routing node of the present invention is adapted to intercept certain SMS related signaling messages prior to their reaching a serving MSC node and subsequently respond to these messages in a manner that is similar to the response normally provided by the serving MSC. However, instead of routing the signaling messages generated in response to these intercepted SMS messages via the normal core mobile SS7 signaling network, an SMO routing node of the present invention routes the signaling messages generated in response to these intercepted SMS messages via an off-load network. As such, one of the primary objectives of an SMO routing node is to provide a method by which a wireless network operator can divert SMS messages originated by mobile subscribers within the their network around the MSC nodes that are servicing those mobile subscribers. To accomplish this objective within the context of current GSM wireless network architectures, such SMS message diversion preferably occurs on the A-interface links that connect BSC nodes to MSC nodes. In conjunction with this objective, it will be appreciated that an equally important

consideration is the ability of an SMO routing to perform the desired SMS off-loading function in a manner that is transparent to other elements in the core SS7 network component of the wireless network, particularly the MSC node from which the SMS messaging traffic is being diverted. Because the present invention off-loads traffic upstream from the MSC, the processing load on the MSC caused by SMS traffic is reduced.

It will be understood that various details of the invention may be changed without departing from the scope of the invention. Furthermore, the foregoing description is for the purpose of illustration only, and not for the purpose of limitation—the invention being defined by the claims.